Project on model coupling between atmosphere and ionosphere

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Recent atmospheric and/or ionospheric observations have increased the importance of understanding the vertical coupling processes between the atmosphere and ionosphere. Even during geomagnetically quiet periods, day-to-day variability of ionospheric phenomena, such as the development of an equatorial ionospheric anomaly and the occurrence of a plasma bubble, can be observed by ground-based optical imagers, radars, and GPS receivers. Seasonal and longitudinal dependences can also be observed by spacecraft instruments. Such variations in the ionospheric phenomena are believed to be affected by atmospheric conditions through the atmospheric dynamo process. In fact, observations in recent years suggest a close relationship between the atmospheric waves originating in the lower atmosphere and ionospheric variations [e.g., Immel et al., 2006; Takahashi et al., 2005]. During storms, moreover, atmosphere-ionosphere interactions are considered to play an important role in causing the observed ionospheric/atmospheric disturbances, such as behaviors of TID/TAD, effects of change in the atmospheric composition and in the neutral wind circulation. These observations have made the role played by a numerical model that can couple the atmosphere and ionosphere more important.

Development of regional coupling models has been very active overseas. For example, TIME-GCM (NCAR) has successfully modeled the upper atmosphere and ionosphere, including electrodynamics. Moreover, some projects couple the entire geospace: the sun, solar wind, magnetosphere, ionosphere, and atmosphere (e.g., CISM and SWMF). In Japan, the troposphere-stratosphere-mesosphere-thermosphere GCM was developed by the universities of Kyushu and Tohoku, and the thermosphere-ionosphere model was developed by NICT independently. In this project, we develop a vertical coupling model between the atmospheric regions and the ionosphere by coupling the two Japanese models and adding the atmospheric dynamo process.

The main scientific targets of this project are as follows: (i) the vertical coupling processes between the lower atmospheric waves and ionospheric variations, (ii) atmosphere-ionosphere interactions in the mid-and low-latitude regions, (iii) atmospheric and ionospheric disturbances during storms, (iv) medium-scale thermosphere-ionosphere interactions (e.g., MSTID), (v) long-term trends in ionospheric variations, and (vi) predictions of ionospheric phenomena. Collaborating with observation campaigns and future satellite missions is also important. We outline our project and report our initial results.